NASA Innovative Advanced Concepts

E-Glider: Active Electrostatic Flight for Airless Body Exploration

Completed Technology Project (2016 - 2017)

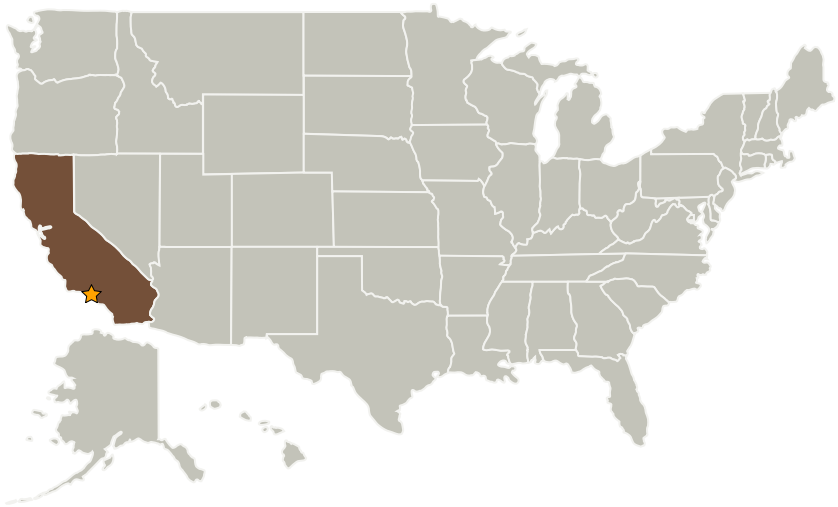
Project Introduction

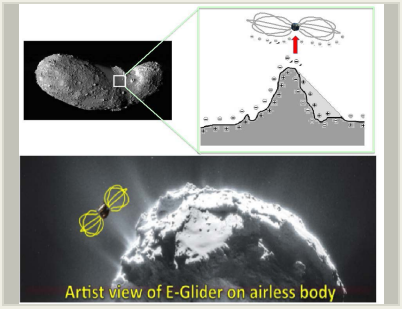
The environment near the surface of airless bodies (asteroids, comets, Moon) is electrically charged due to Sun's photoelectric bombardment. Charged dust is ever present, even at high altitudes (dust fountains), following the Sun's illumination. We envisage the global scale exploration of airless bodies by a gliding vehicle that experiences its own electrostatic lift and drag by its interaction with the naturally charged particle environment near the surface. This Electrostatic Glider (E-Glider) lifts off by extending thin, charged, appendages, which are also articulated to direct the levitation force in the most convenient direction for propulsion and maneuvering. It thus carries out its science mission by circumnavigating the small body, and it lands, wherever it is most convenient, by retracting the appendages or by thruster/anchor.

Anticipated Benefits

This Electrostatic Glider (E-Glider) will enable the global scale exploration of airless bodies by circumnavigating the small body, and it lands, wherever it is most convenient, by retracting the appendages or by thruster/anchor.

Primary U.S. Work Locations and Key Partners





The E-Glider (electrostatic Glider) is a small vehicle that levitates above the surface of an asteroid after extending strands of metallic film, forming the wings, so that it becomes “airborne”, but in the electrostatic vacuum lofting…

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Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California
California Institute of Technology(CalTech)	Supporting Organization	Academia	Pasadena, California
Polytechnic of Torino, Italy	Supporting Organization	Academia	Torino, Outside the United States, Italy
University of California-San Diego(UCSD)	Supporting Organization	Academia	La Jolla, California
University of Colorado Boulder	Supporting Organization	Academia	Boulder, Colorado
University of Tokyo	Supporting Organization	Academia	Tokyo, Outside the United States, Japan

Primary U.S. Work Locations
California

Project Transitions

July 2016: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

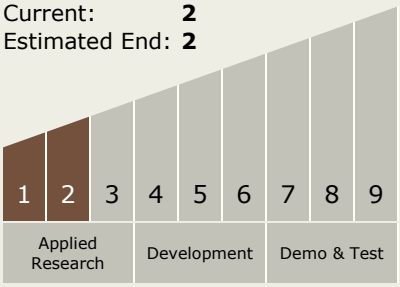
Eric A Eberly

Principal Investigator:

Bruno M Quadrelli

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**



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June 2017: Closed out

Closeout Summary: The environment near the surface of asteroids, comets, a nd the Moon is electrically charged due to the Sun's photoelectric bombardment and lofting dust, which follows the Sun illumination as the body spins. Charged d ust is ever present, in the form of dusty plasma, even at high altitudes, followin g the solar illumination. If a body with high surface resistivity is exposed to the solar wind and solar radiation, sun-exposed areas and shadowed areas become differentially charged. The E-Glider (Electrostatic Glider) is an enabling capability for operation at airless bodies, a solution applicable to many types of in-situ mis sion concepts, which leverages the natural environment. With the E-Glider, we t ransform a problem (spacecraft charging) into an enabling technology, i.e. a ne w form of mobility in microgravity environments using new mechanisms and ma neuvering based on the interaction of the vehicle with the environment. Conseq uently, the vision of the E-Glider is to enable global scale airless body exploratio n with a vehicle that uses, instead of avoids, the local electrically charged enviro nment. This platform directly addresses the "All Access Mobility" Challenge, one of the NASA's Space Technology Grand Challenges. Exploration of comets, aster oids, moons and planetary bodies is limited by mobility on those bodies. The lac k of an atmosphere, the low gravity levels, and the unknown surface soil propert ies pose a very difficult challenge for all forms of know locomotion at airless bodi es. This E-Glider levitates by extending thin, charged, appendages, which are al so articulated to direct the levitation force in the most convenient direction for p ropulsion and maneuvering. The charging is maintained through continuous char ge emission. It lands, wherever it is most convenient, by retracting the appenda ges or by firing a cold-gas thruster, or by deploying an anchor. The wings could be made of very thin Au-coated Mylar film, which are electrostatically inflated, a nd would provide the lift due to electrostatic repulsion with the naturally charge d asteroid surface. Since the E-glider would follow the Sun's illumination, the sol ar panels on the vehicle would constantly charge a battery. Further articulation at the root of the lateral strands or inflated membrane wings, would generate a component of lift depending on the articulation angle, hence a selective maneuv ering capability which, to all effects, would lead to electrostatic (rather than aer odynamic) flight. Preliminary calculations indicate that a 1 kg mass can be electr ostatically levitated in a microgravity field with a 2 m diameter electrostatically i nflated ribbon structure at 19kV, hence the need for a balloon-like system. Due to the high density and the photo-electron sheath and associate small Debye len gth, significant power is required to levitate even a few kilograms. The power re quired is in the kilo-Watt range to maintain a constant charge level.

Closeout Link: https://www.nasa.gov/feature/e-glider-active-electrostatic-fligh t-for-airless-body-exploration

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - TX09.4 Vehicle Systems
    - TX09.4.5 Modeling and Simulation for EDL

Target Destinations

The Moon, Others Inside the Solar System

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Images

Project Image
The E-Glider (electrostatic Glider) is a small vehicle that levitates above the surface of an asteroid after extending strands of metallic film, forming the wings, so that it becomes "airborne", but in the electrostatic vacuum lofting around the asteroid. By articulating the wings, the E-Glider can now hover, and maneuver around, without touching the surface. It is the first circumnavigation of an airless body by electrostatic forces, opening new avenues for low-cost, persistent, reconnaissance of airless bodies, leading to effective global scale prospecting of mineral-rich asteroids.
(https://techport.nasa.gov/image/102275)

Links

NASA.gov Feature Article
(https://www.nasa.gov/feature/e-glider-active-electrostatic-flight-for-airless-body-exploration)